Economics of Security Working Paper Series

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September 2009

Economics of Security Working Paper 16

Correct citation: Drakos, K. (2009). "Cross-country Stock Market Reactions to Major Terrorist Events: The Role of Risk Perception". Economics of Security Working Paper 16, Berlin: Economics of Security.

First published in 2009

ISSN: 1868-0488

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Economics of Security is an initiative managed by DIW Berlin

Cross-country stock market reactions to major terror events: the role of risk perception

Konstantinos Drakos[*♣]

Abstract

The extant literature has established that the occurrence of major terrorist events leads to negative abnormal returns not only to the location of the event, but also to third countries. However, the literature has neither investigated which are the diffusion mechanisms of terrorist shocks, nor whether the diffusion pattern is uniform. Given terrorism's idiosyncrasies and motivated by *memory-based utility* and the *Availability* heuristic, we conjecture that the stock market reaction depends on the country's perceived terrorism risk. We document that terrorism risk perception is able to explain a statistically significant portion of cross-country abnormal returns' variation. Moreover, risk perception's predictive power over abnormal returns is robust, even when we take into account countries' terrorism record or when we control for economic linkages.

Keywords: Behavioral Economics, Risk Perception, Stock Market Return, Terrorism.

JEL: C33, D03, G14, G15.

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[♣] The author acknowledges financial support by the 7th Framework Program (Grant Agreement 218105).

1. Introduction

The empirical literature has econometrically established the significant - and immediate - stock market reaction, to major terrorist attacks, not only in the location of attack, but also in third countries' capital markets (Abadie and Gardeazabal 2003; Carter and Simkins 2004; Chen and Siems 2004; Drakos 2004; Eldor and Melnick 2004; Maillet and Michel 2005; Gulley and Sultan 2006; Amélie and Darné 2006; Nikkinen *et al.*, 2008). However, no study thus far, has investigated any aspect of the underlying diffusion mechanism, or in other words which are the determinants of cross-country reactions. This is exactly the gap the present study aspires to fill.

The cross-country reaction to the news of a major terrorist event occurrence is broadly compatible with the predictions of economic theory, which suggest that major shocks, especially of an adverse nature, typically produce effects transcending their country of origin or occurrence. In particular, economic linkages can provide a channel via which shocks are transmitted, either due to a spillover effect or due to contagion (Calvo and Reinhart 1996; Masson 1998; Wolf 1999; Dornbusch *et al.*, 2000; Forbes and Rigobon 2002).

However, the present paper proposes a behavioral-based, and more importantly independent of linkages, potential driver of stock market reactions. The point of departure is that major terrorist incidents, although definitely fitting the description of adverse shocks affecting capital markets, they possess certain idiosyncrasies, such as high stakes, intense public discussion, immediate and extensive media coverage, and complex emotional content (Fischhoff *et al.*, 2005), what Slovic (2002) concisely articulated as "a new species of trouble". These idiosyncrasies are well capable of triggering reactions, over and beyond those elicited by economic fundamentals, which are essentially driven by, or related to, behavioral factors. In particular, major terrorist attacks are usually catastrophic in nature, causing many fatal casualties and / or extensive property damages. Hence, their occurrence has immediate, direct and pervasive psychosocial consequences that cannot be matched by other adverse economic shocks hitting capital markets. Of critical importance is the potential major terrorist incidents have to adversely affect social mood, and accordingly to deteriorate investor sentiment, where the latter can exercise downward pressure on stock prices (Hirshleifer 2001; Shiller 2003). We further conjecture that the degree of sentiment deterioration, and thus the size of stock market reaction, crucially depends on each country's perceived terrorism risk. This mechanism can generate diverse (stock market) reactions across different receptors (countries), facing an identical stimulus (the realization of a major terrorist attack) and is compatible with the so-called *memory-based utility* (Elster and Loewenstein 1992, Kahneman *et al*., 1997) and one of the behavioral heuristics known as *Availability* (Tversky and Kahneman 1973, 1974; Carroll 1978).

The present study makes a twofold contribution to the literature. Firstly, it explicitly investigates for the first time the cross-country variation in stock market reaction to major terrorist events. Thus, it extends the literature which has so far exclusively focused on whether such events do affect capital markets. Secondly, it provides a behavioral-based explanation for the diffusion of terrorist events' shocks. In doing so we show another, previously ignored, dimension of the manner in which terrorism might affect capital markets. Shedding light on this issue, apart from its pure academic importance, it also has important implications for portfolio management. In particular, by pinning down the determinants of market reactions' to terrorist events, one could exploit this information for diversification purposes.

In the subsequent empirical analysis, we focus on abnormal returns generated from a three-factor world model for daily returns across 29 European countries over the period 2002-2005. Then we investigate whether the cross-country variation of abnormal returns on the days of major terrorist attacks is related to the cross-country variation in terrorism risk perception. We document that terrorism risk perception is able to explain a statistically significant portion of cross-country abnormal returns. Moreover, risk perception retains its predictive power over abnormal returns, even when we take into account countries' terrorism record or when we control for economic linkages.

The remainder of the paper is constructed as follows: Section 2 provides the motivation for the conducted analysis. Section 3 presents the data used. Section 4 describes the econometric methodology employed. Section 5 presents and discusses the empirical results, as well as, conducts sensitivity analysis. Finally, section 6 concludes.

2. Motivation

2.1 The baseline pricing framework

Our departure point is the asset pricing framework driving international stock market returns. The first building block is the standard Capital Asset Pricing Model (Sharpe 1964; Lintner 1965), where in an international context the global value-weighted market portfolio is the relevant risk factor (Grauer *et al*. 1976; Adler and Dumas 1983). Then we consider an international version of the three-factor model (Fama and French 1993, 1996) as follows:

$$E\left(r_{i,t}\right) = \lambda_{wmp}\beta_{i,wmp} + \lambda_{hml}\beta_{i,hml} + \lambda_{smb}\beta_{i,smb} \quad \textbf{(1)}$$

Where $E\left(r_{i,t}\right)$ is the expected return on stock index (i) at time (t) in excess of a risk-free rate, $\lambda_{wmp}=E\left(r_{wmp,t}\right)$, $\lambda_{hml}=E\left(r_{hml,t}\right)$, and $\lambda_{smb}=E\left(r_{smb,t}\right)$ are the risk premia of the World Market Portfolio, the High-minus-Low earnings-price ratio portfolio, and the Small-minus-Big market value portfolio respectively. Similarly, $\beta_{i,wmp}$, $\beta_{i,hml}$, and $\beta_{i,smb}$ are the betas of stock index (i), measuring its sensitivity to each of the risk factors.

This relationship becomes estimable when we allow for a stochastic shock that generates possibly non-spherical deviations from the long-run as follows:

$$\left(r_{i,t}\right)=r_{wmp,t}\beta_{i,wmp}+r_{hml,t}\beta_{i,hml}+r_{smb,t}\beta_{i,smb}+u_{i,t} \qquad \textbf{(2)}$$

2.2 Introducing the terrorism shock

We define $\left(mgt_{c,t}\right)$ as an indicator variable which when attains the value of unity denotes the occurrence of a mega terrorist incident on day (t) and country (c). In contrast, when $\left(mgt_{c,t}\right)$ attains the value of zero there is no major terrorist event. Thus, in order to investigate whether third countries' markets react to the news of major terrorist attacks in another country, we allow the return generation process to differ between 'normal' periods (*i.e* in the absence of major terrorist events) and periods where such events occur. So returns are determined as follows:

$$r_{i,t}=r_{wmp,t}\beta_{i,wmp}+r_{hml,t}\beta_{i,hml}+r_{smb,t}\beta_{i,smb}+\gamma_i\left(mgt_{c,t}\right)+u_{i,t}, \quad i\neq c \qquad \textbf{(3)}$$

The parameter $\left(\gamma_i\right)$ captures the sensitivity of third countries' returns to the news of terrorist attack occurrence in another country and our prior is that it will carry a negative sign. Thus, provided that $\left(\gamma_i\right)<0$, the realization of a terrorist shock will be diffused to third countries. Moreover, the returns in 'normal' periods (*i.e* in the absence of major terrorist events) are driven by fundamentals as described by a standard asset pricing equilibrium model. In contrast during non-normal periods, although fundamentals continue to play a role, returns exhibit a transitory deviation from equilibrium. Hence, the following holds:

$$E\left(r_{i,t} \mid mgt_{c,t} = 1\right) - E\left(r_{i,t} \mid mgt_{c,t} = 0\right) = \gamma_i < 0, \qquad i \neq c \tag{4}$$

This expression suggests that third countries' abnormal returns on days that major terrorist events occur are, on average, lower than returns on normal periods. This is a testable implication that we will explore later on.

2.3 Risk perception as a potential diffusion mechanism

Recall that our main purpose is to investigate if the proposed behavioral-related mechanism could be responsible for determining the extent of a given country's stock market reaction. A distinctive feature of major terrorist events is that, although they certainly fit the general description of an adverse shock, they possess properties that are markedly different from those of other shocks that usually hit financial markets. In particular, major terrorist events are typically catastrophic in nature, causing many fatal casualties and / or substantial property damages. Hence, their occurrence has immediate and direct psychosocial consequences that cannot be matched by other 'standard' adverse shocks hitting capital markets. Moreover, even when compared with other hazards, the perceived severity of mega-terrorist events is so acute that places them in the extreme upper-right quadrant of Slovic's well known two-factor space (Slovic 1987). Factor-1, known as '*dread risk*', measures the hazard's perceived lack of control, dread, catastrophic potential, and fatal consequences. Factor-2, known as '*unknown risk*', measures the extent to which a hazard is perceived as unobservable, unknown, new and delayed in its manifestation of harm.

Essentially, major terrorist incidents have the potential to adversely affect social mood and consequently deteriorate investor sentiment that can exercise downward pressure on stock prices (Hirshleifer 2001; Shiller 2003; Stracca 2004). Significant terrorist events can serve as mood indicators since they easily satisfy the three main criteria proposed by Edmans *et al*. (2007), *i.e*. (i) that they should drive mood in a ample and unambiguous manner, increasing the likelihood that their effect is vigorous enough to be reflected on asset prices, (ii) that they should affect the mood of a large part of the population and therefore it is likely to influence a particular subset of it, *i.e* the stock market participants, and (iii) that their impact should be correlated across agents within a country.

Behavioral economics may also assist us in explaining both why third countries react and also what accounts for the cross-sectional variation of reactions. The observed spillover of shocks is consistent with the phenomenon of *social amplification of risk* (Slovic 1987; Kasperson *et al*,, 1988; Burns *et al*. 1990), but taking place on an international level. Social amplification is triggered by the occurrence of an adverse event that falls into the high-ends of 'dread risk' and/or 'unknown risk' and has consequences that spread outwards, affecting first the immediate victims and then sequentially other agents. It has many times been compared to the dropping of a stone in a pond whose ripples spread ever outward. The variation in magnitude of third countries' market reactions cannot however be explained by the social amplification of risk. Essentially we need a mechanism that has the potential to generate diverse (stock market) reactions among different receptors (countries) facing an identical stimulus (the realization of a given major terrorist attack). We argue that the degree of reaction depends on the receptor's prior perception regarding the level of terrorism risk she faces. Clearly, as we will demonstrate later, neither all countries have identical records of terrorist activity, nor have identical levels of perceived terrorism risk. As it turns out, and in line with one's intuition, the stated terrorism risk perception is highly correlated with a country's past record of terrorism activity. This heterogeneity is rather crucial for the problem at hand, for it has the potential to generate markedly diverse responses to a given mega-terrorist event.

Behavioral economics has shown that current actions, and in particular reactions to a stimulus, may be profoundly affected by the so-called *memory-based utility* (Elster and Loewenstein 1992, Kahneman *et al*., 1997). Memory-based utility qualifies the subject's retrospective evaluation of past episodes and situations as valid data. Thus, we conjecture that agents (investors) in countries with different terrorism risk perceptions due to their dissimilar histories, will also have different memory-based utilities. In other words, the memory-based utility's negative emotions will be stronger and therefore trigger a stronger stock market reaction, in countries with higher terrorism risk perception. Another plausible mechanism, and similar in spirit, might be one of the behavioral heuristics known as *Availability*, according to which one judges the probability of an event by the ease to imagine relevant instances, or by the number of such instances that are readily retrieved from memory (Tversky and Kahneman 1973, 1974; Carroll 1978). From the above discussion emerges the clear-cut testable implication that in the occurrence of a major terrorist event, the cross-country variation of stock market responses will be significantly explained by the cross-country variation in terrorism risk perception.

Going back to the return generation process, we investigate whether third countries' sensitivity to major terrorist events depends on the level of terrorism risk perception. Let $\left(z_{i,t}\right)$ denote a country's terrorism risk perception level. Then in the spirit of Bekaert and Harvey (1995, 1997), Ng (2000), Forbes and Rigobon (2002) and Bekaert *et al*. (2005), we allow third countries' sensitivity to be cross-sectionally varying as follows:

$$\gamma_i = \delta_0 + \delta_{i,1}\left(z_{i,t}\right) \quad \textbf{(5)}$$

Then expression (3) becomes:

$$r_{i,t} = r_{wmp,t}\beta_{i,wmp} + r_{hml,t}\beta_{i,hml} + r_{smb,t}\beta_{i,smb} + \left[\delta_0 + \delta_{i,1}\left(z_{i,t}\right)\right] * \left(mgt_{c,t}\right) + u_{i,t} =$$

$$= r_{wmp,t}\beta_{i,wmp} + r_{hml,t}\beta_{i,hml} + r_{smb,t}\beta_{i,smb} + \delta_0\left(mgt_{c,t}\right) + \delta_{i,1}\left(z_{i,t}\right) * \left(mgt_{c,t}\right) + u_{i,t}$$

(6)

This expression nests various alternative configurations regarding the diffusion of terrorist shocks. For instance, if terrorism had only local effects, *i.e*. affecting only the country that experiences the terrorist event, and therefore third countries did not react, the following would hold:

$$\delta_0 = \delta_{i,1} = 0 \quad \textbf{(7)}$$

Another possibility is that third countries react but in a uniform manner, *i.e*. terrorism risk perception plays no role in the diffusion of terrorist shocks:

$$\delta_0 < 0 \wedge \delta_{i,1} = 0 \quad \textbf{(8)}$$

Finally, the situation where third countries do react but the diffusion of shocks is non-uniform would imply that:

$$\delta_0 < 0,\ \delta_{i,1} < 0 \qquad \textbf{(9)}$$

Suppose for the time being that the sign configuration shown in (9) is valid, then it would imply that:

$$E\left(r_{i,t} \mid mgt_{c,t} = 1\right) - E\left(r_{i,t} \mid mgt_{c,t} = 0\right) = \delta_0 + \delta_{i,1} E\left(z_{i,t}\right) < 0, \qquad i \neq c \qquad \textbf{(10)}$$

This expression has two testable implications: (i) third countries' abnormal returns (stock market reactions) are significantly lower on days of major terrorist events' occurrence, *i.e* terrorist shocks are diffused cross-nationally, and (ii) the size of reaction (absolute magnitude of abnormal returns) increases with the level of terrorism risk perception.

3. Data issues

3.1 Returns and systematic risk factors

Daily closing prices from 1/1/2002 to 30/12/2005 in local currencies for broad stock market indices where obtained from **Datastream** as follows: ATX (Austria), BEL 20 Price (Belgium), BSE SOFIX (Bulgaria), CROBEX (Croatia), Cyprus General (Cyprus), PRAGUE SE PX (Czech Republic), OMX 20 COPENHAGEN (Denmark), OMX TALLINN (Estonia), OMX HELSINKI (Finland), CAC 40 (France), DAX 30 (Germany), ATHEX Composite (Greece), Budapest BUX Price Index (Hungary), IRELAND SE OVERALL ISEQ (Ireland), MILAN MIDEX (Italy), OMX RIGA (Latvia), OMX VILNIUS (Lithuania), Luxemburg SE General (Luxemburg), MSE (Malta), AMSTERDAM SE ALL SHARE PRICE INDEX (Netherlands), WARSAW GENERAL INDEX (Poland), PSI GENERAL (Portugal), BET COMPOSITE INDEX

(Romania), SAX INDEX (Slovakia), SB 120 (Slovenia), Madrid SE General (Spain), OMX STOCKHOLM (Sweden), ISE NATIONAL 100 (Turkey), FTSE All Share (UK).

The three benchmark portfolios denoting the risk factors are proxied by the global equity market portfolios maintained by World Morgan Stanley Capital International (MSCI World) indices as follows: $\left(r_{wmp,t}\right)$ defined as the return on the world market portfolio, $\left(r_{smb,t}\right)$ defined as the difference between the return on a world portfolio of small capitalization stocks and the return on a portfolio of large capitalization stocks (smb, small minus big), $\left(r_{hml,t}\right)$ defined as the difference between the return on a world portfolio of high book-to-market stocks (value) and the return on low book-to-market (growth) stocks (hml, high minus low), which proxies the value of distress premium.

Table 1 provides the main descriptive statistics for countries' daily returns as well as for the benchmark portfolios (risk factors).

----------***Table 1***----------

3.2 Measuring terrorism risk perception

In order to proxy terrorism risk perception we resort to the Eurobarometer which is a harmonized micro survey of representative samples for each EU member state (including the Candidate countries). Certain Eurobarometer surveys include a question that asks respondents to state which are the two most important issues their country faces. The exact phrasing of the question is:

*"**What do you think are the two most important issues facing (OUR COUNTRY) at the moment?**"*

Respondents are shown a card listing the following: crime, public transport, economic situation, rising prices / inflation, taxation, unemployment, **terrorism**, defence

/ foreign affairs, housing, immigration, health care system, educational system, pensions, protecting the environment, others (spontaneous), DK. In particular, we use the following Eurobarometer issues for EB 57.2 (2002), EB 60.1 (2003), EB 62 (2004), EB 64.2 (2005) and CCEB 2003.2 for candidate countries. Based on the micro data we calculate the percentage of respondents by country and year that mentioned terrorism as being one of the two most important issues their country faced:

$$\left(trp_{i,y}\right)=\left(\frac{n_{i,y}}{N_{i,y}}\right)*100 \tag{11}$$

Where (i) denotes country, (y) year, n the number of respondents mentioning terrorism as one of the two most important issues, and N stands for the total number of respondents participating in the survey. This metric is employed as a proxy for the country's level of terrorism risk perception in the given year. As the metric increases we interpret it as denoting higher perceived terrorism risk. Table 2 shows the basic descriptive statistics of terrorism risk perception by country. The highest risk perception is found in Spain, followed by the UK, Turkey and Denmark with 53.92 %, 23.94 %, 21.56 % and 16.58 % respectively.

----------***Table 2***----------

3.3 Identifying major terrorist attacks: the stimulus

Apparently there is no hard definition of what constitutes a major-terrorist incident and consequently some arbitrariness in the choice of events is in order. In any case, the choice of incidents for our analysis was based on three criteria: (i) it had to be in the post 2002 period for which data on terrorism risk perception is available, (ii) it had to have take place in Europe and (iii) it had to have take place on a trading day (*i.e* stock markets should have been in operation, restriction that excludes events that occurred in weekends and national holidays. In addition, events that occurred after 18:00 GMT were also disregarded. There are four terrorist incidents that satisfied these criteria: the Moscow attack on October 23rd 2002, the Istanbul attack on November 20th 2003, the Madrid attack on March 11th 2004 and the London attack on July 7th 2005. Table 3 provides some important background information related to these attacks.

----------***Table 3***----------

4. Econometric methodology

We use a flexible empirical specification whose core is a three-factor world model where, apart from the current values of the risk factors, we also include up to five lags to capture any non-synchronization in trading. In addition, we allow for a similar autoregressive structure for country returns. In order to capture any calendar anomalies we use fixed month and day effects, over and above year effects (Gibbons and Hess 1981; Jaffe and Westerfield 1985; Kato and Shallheim 1985; Board and Sutcliffe 1988; Choudhry 2001). The employed baseline empirical model is of the following form:

$$\left(r_{i,t}\right)=\alpha_0+\left(\sum_{j=0}^{5}\beta_{wmp,j}r_{wmp,t-j}\right)+\left(\sum_{j=0}^{5}\beta_{smb,j}r_{smb,t-j}\right)+\left(\sum_{j=0}^{5}\beta_{hml,j}r_{hml,t-j}\right)+\left(\sum_{j=1}^{5}\phi_j r_{i,t-j}\right)$$

$$+\left(\text{year effects}\right)+\left(\text{month effects}\right)+\left(\text{day effects}\right)+\mu_i+\varepsilon_{i,t} \tag{12}$$

Given the panel dimension we condition on country heterogeneity allowing for an unobserved effect μ_i treated as random, assuming that $E\left(r_{i,t-j}\mu_i\right)=0 \quad \forall\ i,j,t$.

A well established empirical regularity is the volatility clustering exhibited by daily returns (Engle 1982; Bollerslev 1986). Thus, in order to control for this we employ a Pooled Panel GARCH (PP-GARCH hereafter) model for the conditional volatility of stock returns (Cermeno and Grier 2006). Although multivariate GARCH models are also available, they are not practical for most panel applications because they require the estimation of a large number of parameters which consumes degrees of freedom rapidly. In contrast, PP-GARCH estimation by imposing common dynamics on the variance-covariance process across cross-sectional units reduces the number of parameters dramatically ensuring parsimony. So the properties of the error term are as follows:

$E\left(\varepsilon_{i,t}\right)=0$ and $E\left(\varepsilon_{i,t}^{2}\right)=\sigma_{i,t}^{2}$

In particular, assuming that $\varepsilon_{i,t} \sim N\left[0,\Omega_{i,t}\right]$, *i.e.* are multivariate normal error terms with a time-varying conditional variance-covariance matrix produces a PP-GARCH model (Cermeno and Grier 2006). The variance-covariance matrix $\Omega_{i,t}$ is time-dependent and its diagonal and off-diagonal elements are given by the following equations:

$$\sigma_{i,t}^{2}=\theta_{0}+\sum_{n=1}^{N}\theta_{n}^{*}\sigma_{i,t-n}^{2}+\sum_{l=1}^{L}\eta_{l}v_{i,t-l}^{2}$$

$$\sigma_{i,j,t}=\psi_{0}+\sum_{n=1}^{p}\psi_{n}\sigma_{i,j,t-n}+\sum_{m=1}^{k}\rho_{m}v_{i,t-m}v_{j,t-m},\quad \text{for } i\neq j \tag{13}$$

where the θ^{*}'s, ψ's, η's and ρ's denote unknown constant parameters to be estimated.

4.1 Do mega-terrorist events affect returns?

The first step in our econometric investigation is to test whether returns are indeed affected, and in the predicted direction, by the occurrence of mega-terrorism events. Thus we augment the baseline model (equation 12) with the dummy that identifies the four major terrorist incidents, as follows:

$$\left(r_{i,t}\right)=\alpha_0+\gamma_0\left(mgt_{c,t}\right)+\left(\sum_{j=0}^{5}\beta_{wmp,j}r_{wmp,t-j}\right)+\left(\sum_{j=0}^{5}\beta_{smb,j}r_{smb,t-j}\right)+\left(\sum_{j=0}^{5}\beta_{hml,j}r_{hml,t-j}\right)+\left(\sum_{j=1}^{5}\phi_j r_{i,t-j}\right)$$

$$+\left(\text{year effects}\right)+\left(\text{month effects}\right)+\left(\text{day effects}\right)+\mu_i+\varepsilon_{i,t} \tag{14}$$

4.2 Risk perception as a determinant of stock market reaction

In order to investigate whether risk perception contains significant information for abnormal returns, we recover the residuals $\left(\hat{\varepsilon}_{i,t} \mid mgt_{c,t}=1\right)$ from model (14) focusing on the days of major terrorist events. Then we project the residuals on terrorism risk perception, allowing for up to a third order polynomial structure as follows:

$$\left(\hat{\varepsilon}_{i,t} \mid mgt_{c,t}=1\right)=\gamma_0+\sum_{s=1}^{3}\gamma_s\left(trp_{i,t}\right)^s+u_{i,t} \tag{15}$$

After the estimation stage we proceed with three steps. Firstly, by the means of formal hypotheses testing, we establish the preferred specification. Secondly, we test whether terrorism risk perception contains significant explanatory power over abnormal returns. With respect to the second step we test the following hypotheses:

$$H_0:\gamma_s=0,\ \forall\ s \tag{16}$$

Provided that this set of hypotheses is rejected, it would imply that terrorism risk perception provides a channel of diffusion and furthermore, the diffusion of terrorist shocks is non-uniformly distributed across countries.

5. Empirical results

5.1 Preliminary unconditional analysis

As a prelude to the subsequent econometric analysis we provide a few graphs that will shed light in data properties. Graph 1 shows the cross-section of daily returns across 29 European countries on each of these four terrorist events. The percentage of stock indices that dropped on the day of these attacks ranges from 81 % (on the Moscow attack) to 88% (on the Madrid attack). In addition, the sample means of realized returns were -1.35 % on the Moscow attack, -0.71 % on the Istanbul attack, -1.51 % on the Madrid attack and finally -0.63 % on the London attack. This information however merely provides a general picture of market outcomes on the very same days of attack occurrences. It neither provides evidence for a significant negative impact of these events on stock markets, nor does it convey any information about the determinants of the cross-sectional variation of reactions to these events. These will be assessed in the context of a formal econometric model later on.

----------***Graph 1***----------

In Graph 2 we explore the relationship between observed returns on the days of these terrorist events and terrorism risk perception. The graph indicates that raw returns tend to be more negative as risk perception increases, and moreover non-linearities are present.

----------***Graph 2***----------

5.2 Main Results

Before we embark on the investigation of our main hypotheses, we first estimate the parameters of the three-factor world model under a set of alternative techniques and specifications, with the aim to select the one which more adequately fits daily returns. In particular, we use Random-Effects, and three Pooled Panel GARCH models; a PP-ARCH(1), a PP-ARCH(2) and a PP-GARCH(1,1). Estimation results are given in Table A1 in the Appendix. The RE model is outperformed by its PP-GARCH counterparts since in every specification parameters in the conditional volatility equation are highly significant, suggesting that volatility clustering is present. Then after a sequence of Likelihood Ratio tests, the PP-GARCH(1,1) emerges as the preferred specification. However, for comparison purposes we will also consider residuals from all specifications.

The results in Table 4 correspond to the baseline three-factor world model with the terrorism events dummy. The coefficient of the terrorism dummy attains a negative sign and is highly significant, verifying that on days of major terrorist attack occurrences returns are indeed significantly lower. Thus, we document that the average reaction, *i.e.* across the countries' stock indices has been significantly negative. This finding is in line with the previously reported evidence (see Carter and Simkins 2004; Chen and Siems 2004; Drakos 2004; Eldor and Melnick 2004; Gulley and Sultan 2006; Amélie and Darné 2006; Nikkinen *et al*., 2008).

----------***Table 4***----------

In Table 5 we report the results from projecting abnormal returns to the proxy of countries' terrorism risk perception. Although both the linear and quadratic models are statistically significant, the cubic model outperforms them, leading to a fivefold increase in explained variation. Terrorism risk perception is able to explain about 23 % of the cross-country abnormal returns' variation. The estimated parameters' signs suggest that abnormal returns, *i.e*. the size of the stock market reaction, initially increase (in absolute magnitude) with the level of risk perception, then tend to decrease for intermediate levels of risk perception, and finally start to increase again for high levels of risk perception.

----------***Table 5***----------

5.3 *Sensitivity analysis*

5.3.1 Controlling for past terrorism record

Terrorism risk perception is probably not an exogenous variable, in the sense that it is determined by several country characteristics. Among these characteristics, we expect a country's record of terrorism activity to play a prominent role. In other words, we expect past terrorist record to shape, at least to some extent, risk perception. For this purpose we collected the number of terrorist incidents by country and year from 1980 until 2004, as provided by the **Global Terrorism Database** developed at the University of Maryland, containing both domestic and international incidents (LaFree and Dugan 2007). Then for each country we calculated the sample average of terrorist incidents $(terr)$ at fours points in time: (i) from 1980 to 2001, (ii) from 1980 to 2002, (iii) from 1980 to 2003, and (iv) from 1980 to 2004. Graph 3 depicts the relationship between terrorism risk perception (by country) and historical terrorist intensity up to the previous year. The graph shows a strong positive relationship between the two indicating that terrorism risk perception clearly increases with the level of past terrorism activity.

----------***Graph 3***----------

Furthermore, raw returns on days of terrorist attacks are also related to countries' past terrorist record as shown in Graph 4.

----------***Graph 4***----------

Thus, in order to test whether stock market reactions indeed reflect risk perception, and not merely a country's terrorism track record, we adopt the following tactic. Firstly, we regress abnormal returns on past terrorism activity and recover the residuals. These residuals represent the component of abnormal return not explained by terrorism history. Secondly, we test if terrorism risk perception has any explanatory power over these residuals. Table 6 summarizes the estimation results from these regressions. In Panel A we show the estimation results from the regressions of abnormal returns on past terrorist activity, which suggest that countries with a high record react more vigorously. Thus, given the strong correlation between risk perception and past terrorism record, stock market reactions do reflect a country's terrorism history. However, the estimation results in Panel B indicate that terrorism risk perception contains significant explanatory power for the component of abnormal returns that is orthogonal to past terrorism activity. Thus, we conclude that risk perception affects stock market reactions, over and above a country's terrorism history.

----------***Table 6***----------

5.3.2 Controlling for economic linkages

As mentioned in the Introduction the reaction of third countries can also be interpreted as a contagion phenomenon, broadly defined as the cross-national diffusion of shocks, that can be generated by two rather dissimilar processes (for excellent and extensive reviews see Wolf 1999; Dornbusch *et al.*, 2000). The first process is interdependence, referring to the innate consequence that real and financial linkages act as facilitators of shock transmission, what has been called 'fundamentals-based contagion' (Calvo and Reinhart 1996; Masson 1998; Forbes and Rigobon 2002). Thus, a country's reaction increases as its linkages with the rest of the world deepen. The second process resulting in contagion, abstains from the role of fundamentals, and places more emphasis on various 'irrational' phenomena triggered by investors' behavior (Calvo and Mendoza 2001; Kodres and Pritsker 2001).

Let (i) denote the country and (y) the year. For each country we calculate the sum of its exports $(X_{i,y})$ and imports $(M_{i,y})$, and measure what percentage it represented in global international trade $\left[\sum_{world}(M+X)_{i,y}\right]$. So we proxy a country's real linkages by:

$$real_{i,y} = \left[\frac{(M+X)_{i,y}}{\sum_{world}(M+X)_{i,y}}\right] * 100 \qquad \textbf{(17)}$$

The calculations are based on the IMF's **International Financial Statistics** (IFS) database, which provides the value (in US Dollars) of trade (imports and exports) between a given country and its trading partners.

In a similar manner we proxy the degree of a country's financial linkages by the percentage the sum of its total outward $(OI_{i,y})$ and inward $(II_{i,y})$ investment represented in the global total investment portfolio $\left(\sum_{world}(OI+II)_{i,y}\right)$:

$$fina_{i,y} = \left[\frac{(OI+II)_{i,y}}{\sum_{world}(OI+II)_{i,y}}\right] * 100 \qquad \textbf{(18)}$$

The calculations are based on the IMF's **Coordinated Portfolio Investment Survey** (CPIS) database, which provides information on the stock of cross-border holdings of securities (equity securities and long- and short-term debt securities) valued at market prices prevailing at the end of each year, and broken down by the economy of residence of the issuer of the securities. Note that these securities are not part of the balance of payments data categories of direct investment, reserve assets, or financial derivatives.

Table 7 reports the basic descriptive statistics (for 2002-2005) for the real and financial linkages proxies by country. Starting with real linkages, Germany exhibits the highest degree, followed by France, the UK, and Italy with 8.46 %, 4.77%, 4.39 %, and 3.63 % respectively. As it regards financial linkages, the UK is ranked first, followed by Germany, France, and Luxemburg, with 9.38 %, 7.72 %, 6.78 % and 5.78 % respectively. Also note the strong correlation between the real and financial linkages proxy, which is about 0.82 and is indicative of the commonality in information, precluding their joint inclusion as explanatory variables in any regression model.

----------***Table*** *7*----------

In Table 8 we present the results from two hybrid models that include jointly linkages (either real or financial) and terrorism risk perception. These will assist us in two respects. Firstly, to assess whether terrorism risk perception has any incremental explanatory power when we condition on either form of linkages and secondly, to arrive at the model with the highest explanatory power for abnormal returns.

According to our results, irrespectively to which type of linkages we condition upon, terrorism risk perception has significant incremental explanatory power for abnormal returns. In both specifications we emphatically reject the null hypothesis of zero perception effects (p-value 0.01). In fact, in the presence of risk perception financial linkages are insignificant determinants of abnormal returns. In contrast, real linkages are strong predictors of abnormal returns. These findings provide empirical support for the conjectured behavioral-based mechanism underlying stock market reaction to major terrorism events. The hybrid model that includes both real linkages and terrorism risk perception is able to account for about 31 percent of the cross-country abnormal returns variation. We also consider the possibility that linkages and terrorism risk perception not only work in parallel, but also determine the transmission of shocks jointly. To test for this possibility we augment the hybrid models (linkages and risk perception) by a third order polynomial of their interaction. According to our results interaction effects are insignificant suggesting that shocks are diffused by the two mechanisms separately.

----------***Table 8***----------

6. Conclusions

The extant literature has provided conclusive evidence that stock markets reactions' to major terrorist events are sizeable and also extending to third countries (*i.e*. other than the country witnessing the terrorist attack). The present study econometrically explores the underlying mechanism responsible for third countries' reaction. The analysis considers the ability of terrorism risk perception to explain cross-country abnormal returns. Our results suggest that abnormal returns are indeed significantly related to terrorism risk perception, and furthermore this relation is non-linear. The estimated coefficients suggest a sinoidal pattern, where abnormal returns become more negative for risk perception increases over relatively low levels of the latter. Then the absolute magnitude of abnormal returns decreases for intermediate levels of risk perception, and then starts to increase again for high levels of risk perception. Moreover, risk perception's predictive power over abnormal returns is robust, even when we take into account countries' terrorism record or when we control for economic linkages.

These findings imply that terrorist shocks are diffused through the channel provided by terrorism risk perception, which works as an amplifier. Thus, countries with higher (lower) terrorism risk perception are more likely to witness a higher (lower) stock market reaction. Our results have important implications for practitioners since they shed light into the diffusion mechanism of terrorism shocks. Essentially it is driven by an observed and quantifiable country characteristic, which managers could consider when constructing their portfolios. Given that stock market reaction is not uniform, but depends on the country's risk perception and linkages, it implies that there are still diversification benefits. From a purely academic point of view, these results add another dimension to the spectrum of behavioral effects on capital markets, related to a social phenomenon that has recently undergone an important structural shift.

Future research could explore whether the risk perception channel attains its predictability not only in the occurrence of major terrorist events but also in overall terrorism activity. Moreover, a plausible extension is whether the dependence of market reactions is jointly, and possibly interactively, determined by risk perception and the severity of attacks.

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Appendix

Table A1. Baseline specification for daily stock returns: Three-Factor World Model (2002-2005)				
	Random Effects	**PP-ARCH(1)** [a]	**PP-ARCH(2)**	**PP-GARCH(1,1)**
Regressor	**Point estimate (z-score)** [b]			
	Mean equation			
$r_{wmp,t}$	0.0636 (1.22)	0.2151*** (5.86)	0.1319*** (3.95)	0.2091*** (5.60)
$r_{wmp,t-1}$	1.1307*** (11.07)	0.7926*** (10.51)	0.8319*** (13.01)	0.7231*** (10.07)
$r_{wmp,t-2}$	-1.0205*** (-8.25)	-0.6633*** (-6.95)	-0.6082*** (-7.41)	-0.6568*** (-7.33)
$r_{wmp,t-3}$	1.001*** (8.20)	0.7150*** (7.54)	0.4961*** (5.87)	0.7332*** (8.20)
$r_{wmp,t-4}$	-0.7889*** (-7.95)	-0.5772*** (-7.63)	-0.3726*** (-5.47)	-0.6018*** (-8.39)
$r_{wmp,t-5}$	0.3396*** (7.47)	0.2595*** (7.78)	0.2013*** (6.73)	0.2781*** (8.45)
$r_{smb,t}$	0.0286 (1.27)	0.0040 (0.25)	0.0022 (0.15)	-0.0028 (-0.18)
$r_{smb,t-1}$	0.0134 (0.59)	0.0399** (2.37)	0.0834*** (5.79)	0.0661*** (4.22)
$r_{smb,t-2}$	0.1819*** (8.09)	0.1498*** (9.34)	0.1622*** (10.78)	0.1695*** (10.63)
$r_{smb,t-3}$	0.0128 (0.57)	-0.0083 (-0.49)	-0.0190 (-1.30)	0.0002 (0.01)
$r_{smb,t-4}$	0.0061 (0.27)	0.0269 (1.63)	0.0312*** (2.08)	-0.0143 (-0.85)
$r_{smb,t-5}$	0.0034 (0.16)	0.0051 (0.30)	0.0198 (1.28)	0.0119 (0.77)
$r_{hml,t}$	-0.0250*** (-2.69)	-0.0051 (-0.83)	-0.0303*** (-4.81)	-0.0274*** (-4.06)
$r_{hml,t-1}$	0.3921*** (8.15)	0.2518*** (7.58)	0.2887*** (9.72)	0.2127*** (6.23)
$r_{hml,t-2}$	-0.5228*** (-8.28)	-0.3330*** (-7.09)	-0.3338*** (-8.38)	-0.3134*** (-7.00)
$r_{hml,t-3}$	0.4800*** (7.01)	0.3044*** (5.75)	0.2306*** (4.89)	0.3188*** (6.32)

$r_{hml,t-4}$	-0.4874*** (-7.79)	-0.3617*** (-7.50)	-0.2266*** (-5.17)	-0.3818*** (-8.46)
$r_{hml,t-5}$	0.3321*** (7.08)	0.2453*** (7.10)	0.1893*** (6.11)	0.2501*** (7.43)
$r_{i,t-1}$	-0.0184*** (-2.89)	0.0456*** (13.10)	0.0073* (1.73)	-0.0157*** (-2.66)
$r_{i,t-2}$	0.0263*** (4.14)	0.0188*** (5.64)	0.0638*** (18.24)	0.0341*** (6.39)
$r_{i,t-3}$	-0.0359*** (-5.63)	-0.0310*** (-9.38)	-0.0252*** (-6.77)	-0.0250*** (-3.96)
$r_{i,t-4}$	-0.0061 (-0.96)	-0.0050 (-1.40)	-0.0225*** (-7.20)	0.0015 (0.26)
$r_{i,t-5}$	-0.0221*** (-3.52)	0.0007 (0.255)	0.0175*** (6.49)	-0.0182*** (-3.57)
intercept	0.1549*** (4.63)	0.0790*** (3.10)	0.0901*** (4.03)	0.1177*** (4.63)
Year effects[c]	included	included	included	included
Month effects	included	included	included	included
Day effects	included	included	included	Included
Conditional Variance Equation				
ARCH(1)	-	0.4160*** (56.73)	0.3297*** (46.59)	0.1374*** (42.72)
ARCH(2)	-	-	0.3151*** (46.22)	-
GARCH(1)	-	-	-	0.8623*** (296.02)
intercept	-	0.7968*** (187.20)	0.5579*** (121.45)	0.0110*** (12.36)
Log Likelihood	-	-35693.27	-34877.54	-33067.74
LR Test[d]: PP-ARCH(2) vs. PP-ARCH(1)	1631.46***			
LR Test[d]: PP-GARCH(1,1) vs. PP-ARCH(2)	3619.60***			
Observations	24311			

Notes: (a) PP-ARCH stands for Pooled Panel Autoregressive Conditional Heteroscedasticty, (b) ***, **, * denote significance at the 1, 5 and 10 percent level respectively, (c) Year, Month, Day effects include 3, 11, 4 zero/one dummies identifying each year, month and day, (d) LR stands for Likelihood Ratio**.**

Tables

Table 1. Descriptive statistics for daily index and factor returns (1/1/2002 – 30/12/2005)[a]							
Panel A: country stock market indices							
Country	**mean[b]**	**stdev**	**max**	**min**	**skewness**	**kurtosis**	**# of obs**
Austria	0.117	0.854	2.963	-4.483	-0.539	5.395	992
Belgium	0.023	1.237	9.333	-4.392	0.466	9.730	1026
Bulgaria	0.197	1.464	8.387	-8.237	0.137	8.803	983
Croatia	0.065	1.484	13.258	-13.38	-0.025	28.941	991
Cyprus	0.164	1.161	4.215	-2.993	0.330	4.038	329
Czech Republic	0.131	1.121	3.733	-5.999	-0.456	5.123	1000
Denmark	0.037	1.111	4.969	-5.592	-0.219	6.109	1003
Estonia	0.150	0.932	7.178	-3.937	0.665	10.149	1012
Finland	-0.007	1.694	6.431	-9.231	-0.310	6.210	1004
France	0.001	1.476	7.002	-6.044	0.064	6.587	1026
Germany	0.051	0.898	4.173	-4.173	-0.426	5.619	1020
Greece	0.034	1.030	4.100	-3.838	0.094	3.916	997
Hungary	0.106	1.297	4.361	-6.655	-0.284	4.540	1006
Ireland	0.025	0.988	4.775	-6.124	-0.803	8.178	1011
Italy	0.021	0.921	4.241	-4.773	-0.416	5.622	1016
Latvia	0.108	0.987	4.967	-6.974	-0.411	10.669	996
Lithuania	0.177	1.060	11.865	-13.515	-0.225	49.309	1004
Luxemburg	0.030	0.911	3.494	-5.256	-0.237	5.299	1004
Malta	0.085	0.702	6.097	-3.660	0.979	11.636	951
Netherlands	-0.014	1.653	9.516	-7.169	0.167	7.089	1025
Poland	0.093	1.057	4.422	-3.399	0.109	4.047	1005
Portugal	0.024	0.694	2.330	-3.173	-0.510	5.211	1016
Romania	0.213	1.447	9.241	-10.280	0.053	9.443	984
Slovakia	0.145	1.275	5.827	-5.354	0.110	6.163	882
Slovenia	0.079	0.728	8.310	-4.767	1.487	24.511	972
Spain	0.033	1.121	4.856	-4.338	0.052	5.480	1006
Sweden	0.023	1.242	7.256	-5.346	0.135	6.391	1005
Turkey	0.105	2.219	11.793	-13.340	0.003	7.987	1001
UK	0.011	1.050	5.094	-5.147	-0.203	7.331	1011

Panel B: benchmark portfolios (risk factors)							
MSCI World Market Portfolio	0.018	0.884	4.751	-3.924	0.139	6.544	1043
MSCI World Small	0.047	0.738	3.556	-2.877	-0.192	4.362	1043
MSCI World Large	0.010	0.878	4.766	-3.997	0.138	6.767	1043
MSCI World Value	0.017	0.940	5.423	-4.177	0.151	6.960	1043
MSCI World Growth	0.007	0.848	4.656	-3.867	0.123	6.136	1043
SMB, (Small – Large)	0.036	0.389	1.798	-1.934	-0.177	6.034	1043
HML, (Value – Growth)	0.010	1.185	5.456	-5.917	0.181	5.978	1043

Notes: (a) Percentage change in daily index -based on own calculations- (original source: **Datastream**), (b) mean, stdev, max, min, skewness, kurtosis stand for the sample mean, standard deviation, maximum and minimum, respectively.

Table 2. Terrorism Risk Perception by Country (2002-2005)[a]				
Country[b]	**mean**	**stdev**	**max**	**min**
Austria	5.67	1.90	7.56	3.02
Belgium	6.82	2.39	10.01	4.24
Bulgaria	3.94	1.25	5.08	2.60
Croatia	1.12	0.17	1.25	1.00
Cyprus	4.25	1.52	6.00	3.20
Czech Republic	2.59	0.82	3.53	2.00
Denmark	16.58	5.84	22.52	9.79
Estonia	1.72	0.31	2.00	1.38
Finland	3.95	1.55	5.97	2.18
France	10.01	1.74	11.42	7.47
Germany	5.97	3.74	11.53	3.37
Greece	4.07	2.43	1.90	7.09
Hungary	3.10	2.02	5.42	1.67
Ireland	4.55	1.49	6.60	3.13
Italy	14.15	3.57	16.86	9.03
Latvia	1.92	0.77	2.60	1.07
Lithuania	1.78	0.72	2.59	1.18
Luxemburg	7.18	2.12	10.16	5.17
Malta	2.06	0.83	3.00	1.40
Netherlands	14.69	11.43	31.35	5.46
Poland	3.91	2.01	6.20	2.40
Portugal	3.46	1.37	4.50	1.44
Romania	3.54	0.91	4.19	2.50
Slovakia	3.61	1.84	5.35	1.67
Slovenia	2.23	0.91	3.20	1.39
Spain	53.92	11.78	66.00	38.41
Sweden	4.30	0.97	5.30	3.00
Turkey	21.56	11.72	34.48	11.60
UK	23.94	3.80	26.65	18.57
All countries	8.79	11.59	66.00	1.00

Notes: (a) Percentage of country respondents mentioning terrorism as one of the two most important issues their country faced - based on own calculations- (original source: Eurobarometer issues 57.2, 60.1, 62.0, 64.2), (b) Data for Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia, Slovenia, and Turkey are available from 2003 onwards.

Table 3: Background information on major terrorist attacks used as stimulus

City	Date	Timing	Location	Deaths	Injuries
Moscow	October 23rd 2002	9:05 pm local time (5:00 pm GMT)	Theater	179	656
Istanbul	November 20th 2003	11:10 am local time (9:10 am GMT)	British consulate and offices of HSBC bank	60	400
Madrid	March 11th 2004	7:37 am local time (6:37 am GMT)	Train stations	191	1876
London	July 7th 2005	8:50 – 9:47 am local time	Underground trains, bus	54	700

Table 4. The impact of major terrorist events on returns				
	Random Effects	PP-ARCH(1) [a]	PP-ARCH(2)	PP-GARCH(1,1)
Regressor	Point estimate (z-score) [b, c]			
Mean equation				
$mgt_{c,t}$	-0.6317*** (-4.55)	-0.600*** (-5.06)	-0.5931*** (-5.36)	-0.4807*** (-4.04)
$r_{wmp,t}$	0.0645 (1.07)	0.2176*** (3.24)	0.1408** (1.99)	0.2173*** (4.51)
$r_{wmp,t-1}$	1.1217*** (9.33)	0.7794*** (6.04)	0.8109*** (5.49)	0.7081*** (7.18)
$r_{wmp,t-2}$	-1.010*** (-7.17)	-0.6489*** (-4.21)	-0.5884*** (-3.68)	-0.6368*** (-5.71)
$r_{wmp,t-3}$	0.9872*** (7.27)	0.6993*** (4.88)	0.4754*** (3.32)	0.7005*** (6.55)
$r_{wmp,t-4}$	-0.7782*** (-6.97)	-0.5668*** (-4.88)	-0.3575*** (-3.08)	-0.5786*** (-6.56)
$r_{wmp,t-5}$	0.3359*** (6.32)	0.2552*** (4.49)	0.1940*** (3.46)	0.2705*** (6.46)
$r_{smb,t}$	0.0344 (1.35)	0.0095 (0.36)	0.0095 (0.37)	0.0041 (0.21)
$r_{smb,t-1}$	0.0215 (0.84)	0.0510* (1.74)	0.0960*** (3.17)	0.0756*** (3.53)
$r_{smb,t-2}$	0.1755*** (6.88)	0.1445*** (4.70)	0.1561*** (5.42)	0.1655*** (8.32)
$r_{smb,t-3}$	0.0133 (0.53)	-0.0083 (-0.29)	-0.0209 (-0.69)	-0.0022 (-0.11)
$r_{smb,t-4}$	0.0006 (0.03)	0.0204 (0.73)	0.0265 (0.92)	-0.0188 (-1.02)
$r_{smb,t-5}$	0.0063 (0.27)	0.0089 (0.37)	0.0238 (0.95)	0.0113 (0.56)
$r_{hml,t}$	-0.0224** (-2.18)	-0.0022 (-0.17)	-0.0265** (-2.22)	-0.0242*** (-2.71)
$r_{hml,t-1}$	0.3929*** (6.99)	0.2513*** (3.92)	0.282*** (3.99)	0.2065*** (4.40)
$r_{hml,t-2}$	-0.5175*** (-6.96)	-0.3249*** (-4.09)	-0.3242*** (-3.74)	-0.3085*** (-5.21)
$r_{hml,t-3}$	0.4753*** (6.18)	0.2987*** (3.56)	0.2209*** (2.77)	0.3041*** (5.08)

$r_{hml,t-4}$	-0.4801*** (-6.90)	-0.3547*** (-4.96)	-0.2171*** (-2.99)	-0.3653*** (-6.61)
$r_{hml,t-5}$	0.3306*** (6.14)	0.2445*** (4.27)	0.1857*** (3.33)	0.2435*** (5.88)
$r_{i,t-1}$	-0.0182 (-1.36)	0.0445 (1.14)	0.0062 (0.23)	-0.0162 (-1.60)
$r_{i,t-2}$	0.0260** (2.21)	0.0183 (1.09)	0.0626** (2.05)	0.0339*** (3.12)
$r_{i,t-3}$	-0.036*** (-3.46)	-0.0318* (-1.90)	-0.0262 (-1.64)	-0.0261*** (-3.17)
$r_{i,t-4}$	-0.0053 (-0.51)	-0.0034 (-0.27)	-0.0212 (-1.31)	0.0027 (0.31)
$r_{i,t-5}$	-0.0214** (-2.22)	0.0021 (0.12)	0.0187 (1.13)	-0.0170* (-1.70)
intercept	0.1541*** (4.50)	0.0787** (2.13)	0.0900*** (2.36)	0.1174*** (3.99)
Year effects[d]	Included	included	included	included
Month effects	Included	included	included	included
Day effects	Included	included	included	included
Conditional Variance Equation				
ARCH(1)	-	0.4186*** (11.72)	0.3308*** (11.81)	0.1368*** (14.05)
ARCH(2)	-	-	0.3139*** (8.99)	-
GARCH(1)	-	-	-	0.8628*** (91.28)
intercept	-	0.7939*** (27.89)	0.5569*** (23.51)	0.010*** (4.64)
Log Likelihood	-	-35671.09	-34852.94	-33047.58
LR Test[e]: PP-ARCH(2) vs. PP-ARCH(1)	1636.30***			
LR Test: PP-GARCH(1,1) vs. PP-ARCH(2)	3610.72***			
Observations	24311			

Notes: (a) PP-GARCH stands for Pooled Panel Generalised Autoregressive Conditional Heteroscedasticty, (b) ***, **, * denote significance at the 1, 5 and 10 percent level respectively, (c) z-scores based on robust standard errors, (d) Year, Month, Day effects include 10, 11, 4 zero/one dummies identifying each year, month and day, (e) LR stands for Likelihood Ratio**.**

Table 5. Terrorism risk perception and abnormal returns on days of major terrorist events												
Abnormal returns from:	**Random Effects**			**PP-ARCH(1)**			**PP-ARCH(2)**			**PP-GARCH(1,1)**		
Point estimate (t-test) [a, b]												
Regressor	**Linear**	**Quadratic**	**Cubic**	**Linear**	**Quadratic**	**Cubic**	**Linear**	**Quadratic**	**Cubic**	**Linear**	**Quadratic**	**Cubic**
Panel C: Terrorism Risk Perception [c]												
(trp)	-0.023*** (-2.66)	-0.104*** (-3.17)	-0.328*** (-4.30)	-0.024*** (-2.72)	-0.104*** (-3.14)	-0.332*** (-4.33)	-0.023*** (-2.66)	-0.104*** (-3.16)	0.335*** (-4.41)	-0.023*** (-2.66)	-0.106*** (-3.15)	-0.344*** (-4.51)
$(trp)^2$	-	0.001*** (2.49)	0.013*** (4.00)	-	0.001*** (2.43)	0.013*** (4.05)	-	0.001*** (2.47)	0.013*** (4.11)	-	0.001*** (2.45)	0.013*** (4.23)
$(trp)^3$	-	-	-0.00013*** (-3.86)	-	-	-0.00013*** (-3.93)	-	-	-0.00013*** (-3.97)	-	-	-0.00014*** (-4.10)
R^2	4.06 %	10.67 %	22.02 %	4.24 %	10.66 %	22.35 %	4.19 %	10.86 %	23.12 %	4.21 %	10.85 %	23.49 %
F-test	7.06***	6.36***	8.46***	7.38***	6.39***	8.93***	7.10***	6.29***	8.67***	7.18***	6.33***	9.01***
Notes: (a) ***, **, * denote significance at the 1, 5 and 10 percent level respectively, (b) t-tests based on robust standard errors, (c) estimation is based on 91 observations.												

Table 6. Sensitivity analysis I: removing the effect of past terrorism record

Panel A: Past terrorism record and abnormal returns

Abnormal returns from:	**Random Effects**		**PP-ARCH(1)**		**PP-ARCH(2)**		**PP-GARCH(1,1)**	
	Point estimate (t-test) [a, b]							
Regressor	**Linear**	**Quadratic**	**Linear**	**Quadratic**	**Linear**	**Quadratic**	**Linear**	**Quadratic**
$(terr)$	-0.015*** (-2.99)	-0.049*** (-3.71)	-0.016*** (-3.01)	-0.049*** (-3.67)	-0.015*** (-2.95)	-0.048*** (-3.61)	-0.015*** (-3.00)	-0.049*** (-3.57)
$(terr)^2$	-	0.0003*** (3.13)	-	0.0003*** (3.05)	-	0.0003*** (3.03)	-	0.0003*** (2.94)
$(terr)^3$	-	-	-	-	-	-	-	-
R^2	12.71 %	16.60 %	13.02 %	16.83 %	12.73 %	16.56 %	12.72 %	16.51 %
F-test	8.93***	7.31***	9.05***	7.27***	8.68***	6.98***	8.97***	7.02***

Panel B: Terrorism risk perception and abnormal returns unexplained by past terrorism record

Regressor	**Random Effects**	**PP-ARCH(1)**	**PP-ARCH(2)**	**PP-GARCH(1,1)**
(trp)	-0.256*** (-3.61)	-0.259*** (-3.66)	-0.264*** (-9.74)	-0.272*** (-3.84)
$(trp)^2$	0.011*** (3.76)	0.011*** (3.83)	0.011*** (3.89)	0.012*** (4.01)
$(trp)^3$	-0.0001*** (-3.69)	-0.0001*** (-3.78)	-0.0001*** (-3.82)	-0.0001*** (-3.95)
R^2	14.77%	15.01%	15.79%	16.17%
F-test	6.48***	6.23***	6.14***	6.43***

Notes: (a) ***, ** denote significance at the 1 and 5 percent level respectively, (b) t-tests based on robust standard errors, (c) estimation is based on 91 observations.

Table 7. Real and Financial linkages by country (2002-2005)								
	Real linkages[a]				Financial linkages[b]			
Country	**mean**	**stdev**	**max**	**min**	**mean**	**stdev**	**max**	**min**
Austria	1.08	0.03	1.12	1.05	1.07	0.03	1.11	1.04
Belgium	2.66	0.02	2.69	2.63	1.73	0.07	1.82	1.63
Bulgaria	0.11	0.01	0.13	0.09	0.01	0.002	0.01	0.008
Croatia	0.11	0.005	0.12	0.10	0.01	0.002	0.02	0.01
Cyprus	0.07	0.006	0.08	0.06	0.03	0.008	0.04	0.02
Czech Republic	0.63	0.03	0.66	0.58	0.05	0.01	0.06	0.04
Denmark	0.72	0.01	0.74	0.70	0.67	0.05	0.73	0.60
Estonia	0.08	0.004	0.09	0.07	0.009	0.002	0.01	0.006
Finland	0.63	0.01	0.64	0.60	0.72	0.03	0.76	0.68
France	4.77	0.18	4.94	4.51	6.78	0.35	7.09	6.32
Germany	8.46	0.21	8.71	8.21	7.72	0.41	8.02	7.12
Greece	0.35	0.01	0.37	0.33	0.47	0.09	0.55	0.34
Hungary	0.57	0.01	0.58	0.54	0.08	0.01	0.10	0.07
Ireland	1.07	0.05	1.14	1.01	3.24	0.29	3.55	2.89
Italy	3.63	0.12	3.77	3.46	4.55	0.20	4.74	4.26
Latvia	0.07	0.003	0.08	0.06	0.001	0.0004	0.002	0.001
Lithuania	0.10	0.006	0.11	0.09	0.005	0.001	0.006	0.004
Luxemburg	0.18	0.01	0.20	0.16	5.78	0.15	5.95	5.58
Malta	0.04	0.006	0.05	0.04	0.02	0.018	0.05	0.01
Netherlands	3.37	0.03	3.39	3.31	4.88	0.14	5.00	4.66
Poland	0.75	0.04	0.81	0.67	0.10	0.03	0.14	0.06
Portugal	0.53	0.02	0.56	0.49	0.52	0.02	0.54	0.50
Romania	0.28	0.03	0.32	0.23	0.009	0.002	0.01	0.007
Slovakia	0.27	0.02	0.29	0.23	0.01	0.003	0.02	0.01
Slovenia	0.17	0.006	0.18	0.16	0.007	0.002	0.009	0.004
Spain	2.28	0.08	2.35	2.16	2.43	0.22	2.65	2.15
Sweden	1.17	0.03	1.20	1.14	1.21	0.03	1.25	1.16
Turkey	0.75	0.10	0.85	0.62	0.08	0.02	0.11	0.06
UK	4.39	0.25	4.67	4.07	9.38	0.22	9.69	9.17
All countries	1.35	1.90	8.71	0.04	1.78	2.66	9.69	0.0014

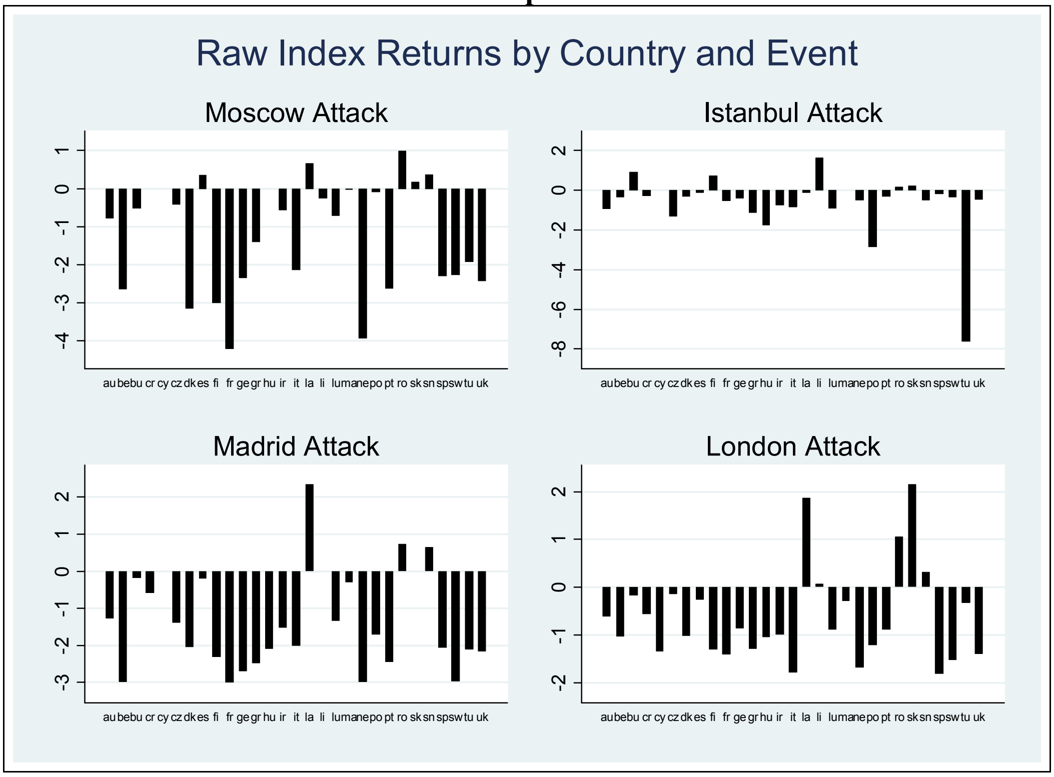
Notes: (a) Country share (percentage) in world total investment portfolio -based on own calculations- (original source**: IMF Coordinated Portfolio Investment Survey),** (b) Country share (percentage) in international trade -based on own calculations- (original source: **IMF International Financial Statistics**).

Table 8. Sensitivity Analysis II: the effect of terrorism risk perception controlling for linkages[a]				
Regressor	**Point estimate (t-test)[b, c]**			
$(real)$	-1.61*** (-3.60)	-	-1.82*** (-3.40)	-
$(real)^2$	0.471*** (2.96)	-	0.508*** (2.96)	-
$(real)^3$	-0.035** (-2.60)		-0.037** (-2.46)	-
$(fina)$	-	-0.603 (-1.34)	-	-0.732* (-1.78)
$(fina)^2$	-	0.151 (1.39)	-	0.175 (1.22)
$(fina)^3$	-	-0.0097 (-1.30)	-	-0.012 (-1.02)
(trp)	-0.260** (-2.51)	-0.311** (-2.61)	-0.295** (-2.38)	-0.322** (-2.10)
$(trp)^2$	0.011*** (2.81)	0.0126*** (2.77)	0.012*** (3.17)	0.012** (2.37)
$(trp)^3$	-0.0001*** (-2.94)	-0.00012*** (-2.82)	-0.00013*** (-3.54)	-0.00012** (-2.44)
$(real*trp)$	-	-	0.044 (0.58)	-
$(real*trp)^2$	-	-	-0.00092 (-0.90)	-
$(real*trp)^3$	-	-	0.0000005 (1.08)	-
$(fina*trp)$	-	-	-	0.019 (0.42)
$(fina*trp)^2$	-	-	-	-0.0002 (-0.55)
$(fina*trp)^3$	-	-	-	0.00000007 (0.72)
R^2	0.315	0.256	0.320	0.268
F-test: overall significance	9.54***	7.31***	7.21***	6.22***
F-test: zero perception effects	3.76**	3.00**	6.20***	2.67**
F-test: zero real linkages effects	4.69***	-	4.44***	-
F-test: zero financial linkages effects	-	1.10	-	1.34
F-test: zero interaction effects	-	-	0.80	2.07
Observations	91	91	91	91

Notes: (a) Estimation based on the PP-GARCH(1,1) abnormal returns, (b) ***, **, * denote significance at the 1, 5 and 10 percent level respectively, (c) t-tests based on robust standard errors.

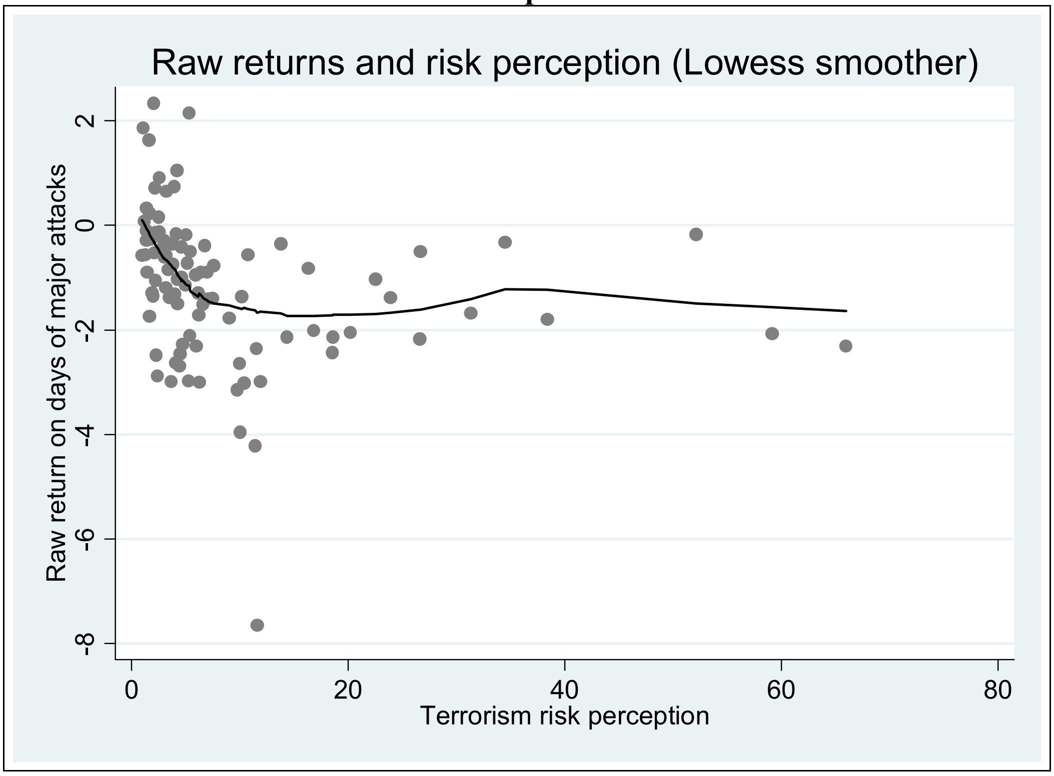
Graphs

Graph 1



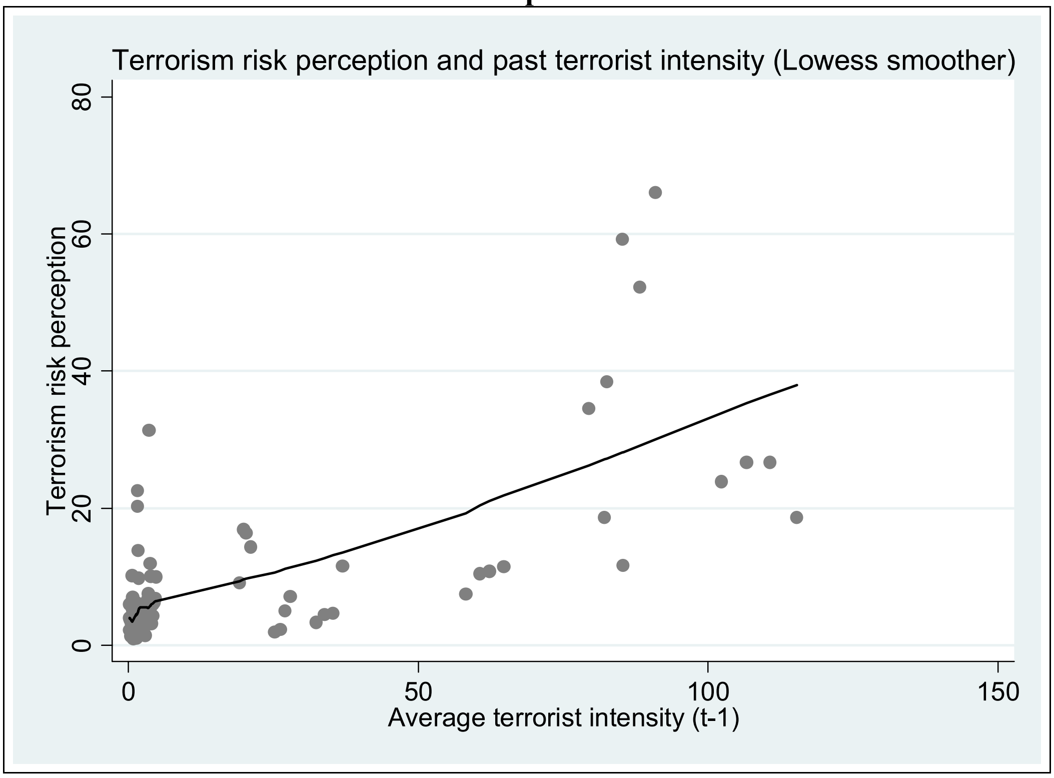
Notes: au, be, bu, cr, cy, cz, dk, es, fi, fr, ge, gr, hu, ir, it, la, li, lu, ma, ne, po, pt, ro, sk, sn, sp, sw, tu, uk stand for Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxemburg, Malta, Netherlands, Poland, Portugal, Romania, Slovak Republic, Slovenia, Spain, Sweden, Turkey and United Kingdom respectively.

Graph 2



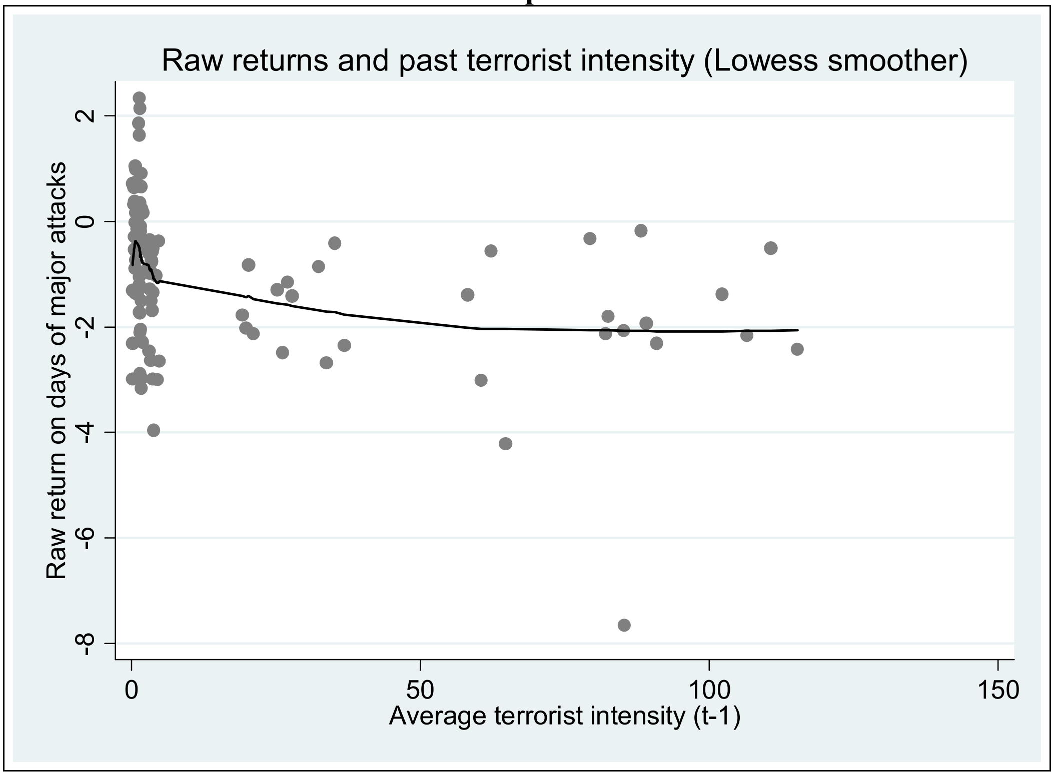
Notes: Based on pooled data across the four major terrorist incidents (Moscow, Istanbul, Madrid, London). Terrorism Risk Perception denotes the percentage of Eurobarometer respondents by country and year mentioning terrorism as one of the two most important issues their country faced at the time of the survey. Raw Index Returns denotes the daily return based on each (third) country's stock index on the day of major terrorist attack occurrences.

Graph 3



Notes: Average terrorist intensity denotes the sample mean of terrorist incidents calculated at four points in time (1980-2001, 1980-2002, 1980-2003, 1980-2004) for each country. Each mean is plotted against the country's terrorism risk perception index in the following year (Moscow 2002, Istanbul 2003, Madrid 2004, London 2005).

Graph 4



Notes: Average terrorist intensity denotes the sample mean of terrorist incidents calculated at four points in time (1980-2001, 1980-2002, 1980-2003, 1980-2004) for each country. Each mean is plotted against the country's raw return on the day of major terrorist attack in the following year (Moscow 2002, Istanbul 2003, Madrid 2004, London 2005).